Remarks

Reconsideration and reexamination of the above-identified patent application, as amended, are respectfully requested. Claims 1, 3-7, and 9-13 are pending in this application upon entry of this Amendment. In this Amendment, the Applicant has amended claims 1, 3, and 7; and cancelled claims 2, 8, and 14-15. No claims have been added in this Amendment. Of the pending claims, claims 1 and 7 are the only independent claims.

Claim Rejections - 35 U.S.C. § 103

In the final Office Action mailed September 20, 2005, the Examiner rejected claims 1-2, 6-8, and 11 (which include independent claims 1 and 7) under 35 U.S.C. § 103(a) as being unpatentable over JP 53119724 ("JP '724") in view of U.S. Patent No. 4,820,345 issued to Berg et al. ("Berg").

The Examiner rejected claim 3 under 35 U.S.C. § 103(a) as being unpatentable over JP '724 in view of Berg in further view of U.S. Patent No. 5,281,242 issued to Sadan ("Sadan"). The Examiner rejected claims 4-5 and 9-10 under 35 U.S.C. § 103(a) as being unpatentable over JP '724 in view of Berg in further view of U.S. Patent No. 4,423,764 issued to Seeney et al. ("Seeney"). The Examiner rejected claims 12 and 14 under 35 U.S.C. § 103(a) as being unpatentable over JP '724 in view of Berg in further view of JP 63132745 ("JP '745"). The Examiner rejected claims 13 and 15 under 35 U.S.C. § 103(a) as being unpatentable over JP '724 in view of Berg in further view of U.S. Patent No. 4,761,264 issued to Nishio et al. ("Nishio").

1. The Claimed Invention

The claimed invention is generally directed to a water-soluble casting mold and its manufacture. Amended independent claim 1 recites a water-soluble casting mold. The mold comprises a mixture having a refractory granular material for casting sand and a

water-soluble binder containing an inorganic sulfate compound comprising magnesium sulfate and at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate. The inorganic sulfate compound exists in a state of hydrate containing crystal water after the mixture is dried.

Amended independent claim 7 recites a method for manufacturing a water-soluble casting mold. The method includes a first step of obtaining casting sand by mixing a refractory granular material for casting sand with a water-soluble binder containing an inorganic sulfate compound comprising magnesium sulfate and at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate and water. The method further includes a second step of forming the resulting casting sand. The method further includes a third step of obtaining a mold by drying the casting sand in such a manner that the inorganic sulfate compound in the casting sand is kept retaining at least a portion of the crystal water.

Support for amended independent claims 1 and 7 is found, for example, in the description and explanation of tables 2-7 disclosed in the Applicant's specification.

A feature of the claimed invention is to increase the strength of a water-soluble casting mold by adjusting an inorganic sulfate compound contained in a water-soluble binder to be in a state of hydrate containing crystal water after drying.

Another feature of the claimed invention is to use magnesium sulfate in combination with another inorganic sulfate compound (i.e., at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate) which easily forms a mixed crystal with magnesium sulfate at the time of drying, thereby increasing the strength of a water-soluble casting mold at the time of drying, and also restraining the decrease in the strength of a water-soluble casting mold at the time of moisture absorption.

2. The Claimed Invention Compared to the Cited Art

A. JP 53119724 (JP '724)

Page 2, lines 13-19 and page 3, lines 5-16 of the Applicant's specification describe the pertinence of JP '724. As is explained, JP '724 discloses, for example, a technique of using magnesium sulfate as a binder for a refractory granular material for casting sand and mixing the refractory granular material with magnesium sulfate and water, thereafter forcibly drying the obtained mixture at a temperature of 200° to 300°C, thereby obtaining a mold (see page 2, lines 13-19 of the Applicant's specification). However, with respect to the mold disclosed in JP '724, because magnesium sulfate hydrate is dehydrated at a temperature of 200°C or higher, the magnesium sulfate in the obtained mold is supposed to be an anhydride. Magnesium sulfate in the anhydride state has a rather decreased strength as compared with that in a hydrate state containing water. Therefore, in order to retain a sufficient strength of the mold, the additional amount of magnesium sulfate has to be increased and that is significantly disadvantageous in terms of moldability of the mold, easiness of drying, and recovery of the binder and thereby results in a decrease of working efficiency (see page 3, lines 5-16 of the Applicant's specification).

JP '724 does not teach or suggest the technical idea of increasing the strength of a water-soluble casting mold by adjusting an inorganic sulfate compound contained in a water-soluble binder to be in a state of hydrate containing crystal water after drying. Also, JP '724 does not teach or suggest the technical idea of using magnesium sulfate in combination with another inorganic sulfate compound (i.e., at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate) which easily forms a mixed crystal with magnesium sulfate at the time of drying, thereby increasing the strength of a water-soluble casting mold at the time of drying, and also restraining the decrease in the strength of a water-soluble casting mold at the time of moisture absorption.

B. U.S. Patent No. 4,820,345 ("Berg")

Berg is directed to a water and fire resistant building material. As such, Berg belongs to a quite different technical field from that of the claimed invention. Further, Berg discloses using magnesium chloride or magnesium sulfate as part of a binder composition of the building material, and forming a magnesium cement hydrate storing water in the form of crystalline water (see col. 2, lines 59-68 of Berg). Berg also discloses that the magnesium cement gives off water over a wide temperature range in high temperatures as in a fire, and in this way acts to limit the temperature and to smother the fire (see col. 3, lines 1-7 of Berg).

As explained above, Berg discloses a magnesium cement hydrate storing water in the form of crystalline water which is to improve fire resistance of the building material. However, Berg does not teach or suggest a water-soluble binder for a casting mold. That is, it is difficult for one having ordinary skill in the art to reach the idea of combining the teachings of Berg with the teachings of JP '724 which belong to quite different technical fields.

Further, Berg does not teach or suggest the technical idea of increasing the strength of a water-soluble casting mold by adjusting an inorganic sulfate compound contained in a water-soluble binder to be in a state of hydrate containing crystal water after drying. Also, Berg does not teach or suggest the technical idea of using magnesium sulfate in combination with another inorganic sulfate compound (i.e., at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate) which easily forms a mixed crystal with magnesium sulfate at the time of drying, thereby increasing the strength of a water-soluble casting mold at the time of drying, and also restraining the decrease in the strength of a water-soluble casting mold at the time of moisture absorption.

Therefore, the claimed invention as set forth in claims 1, 6-7, and 11, as amended, is patentable under 35 U.S.C. § 103(a) over JP '724 in view of Berg.

C. U.S. Patent No. 5,281,242 ("Sadan")

Sadan is directed to a method for recovering magnesium sulfate products from a mixture of epsomite and halite. Sadan discloses that the resulting monohydrate magnesium sulfate product is particularly useful as desiccant because the material can absorb up to 100% of its weight in water without caking (see col. 6, lines 15-18 of Sadan).

Sadan does not teach of suggest using monohydrate magnesium sulfate as a water-soluble binder for a casting mold, and does not teach or suggest the technical idea of increasing the strength of a water-soluble casting mold by using monohydrate magnesium sulfate as a water-soluble binder for the casting mold. Also, Sadan does not teach or suggest the technical idea of using magnesium sulfate in combination with another inorganic sulfate compound (i.e., at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate) which easily forms a mixed crystal with magnesium sulfate at the time of drying, thereby increasing the strength of a water-soluble casting mold at the time of drying, and also restraining the decrease in the strength of a water-soluble casting mold at the time of moisture absorption.

Therefore, the claimed invention as set forth in claim 3 (which was amended to depend from amended independent claim 1) is patentable under 35 U.S.C. § 103(a) over JP '724 in view of Berg in further view of Sadan.

D. U.S. Patent No. 4,423,764 ("Seeney")

Seeney discloses using aluminum dihydrogen phosphate and potassium polyphosphate for binder and hardener of casting molds (see col. 1, lines 33-43 of Seeney).

Seeney does not teach or suggest the technical idea of making the inorganic sulfate compound exist in a state of hydrate containing crystal water after drying, and thereby, increasing the strength of a water-soluble casting mold. Also, Seeney does not teach or suggest

using various phosphate compounds together with an inorganic sulfate compound so as to retain the water-solubility of the mold and improve the heat resistance. Furthermore, it is to be noted that aluminum dihydrogen phosphate has no effect in enhancing the heat resistance of a water-soluble casting mold, even if it is combined with magnesium sulfate heptahydrate.

Furthermore, Seeney does not teach or suggest the technical idea of using magnesium sulfate in combination with another inorganic sulfate compound (i.e., at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate) which easily forms a mixed crystal with magnesium sulfate at the time of drying, thereby increasing the strength of a water-soluble casting mold at the time of drying, and also restraining the decrease in the strength of a water-soluble casting mold at the time of moisture absorption.

Therefore, the claimed invention as set forth in claims 4-5 (which depend from amended independent claim 1) and as set forth in claims 9-10 (which depend from amended independent claim 7) is patentable under 35 U.S.C. § 103(a) over JP '724 in view of Berg in further view of Seeney.

E. JP 63132745 ("JP '745")

JP '745 is directed to a method for producing a water-soluble casting mold. In this method, the slurry is prepared by adding water to a mixture containing the gypsum, phlogopite, hydrate of $MgSO_4$ and refractories. The slurry is poured into a mold and is molded under pressure, thereby, a molding having a shape of the casting mold is obtained. After the molding is subjected to primary drying at a temperature equal or lower than 120°C, the molding is subjected to secondary drying at a temperature equal or higher than 200°C.

JP '745 discloses that the secondary drying is conducted at a temperature equal or higher than 200°C so as not to remain crystal water by causing a dehydration reaction in the gypsum ($MgSO_4 \cdot 1/2H_2O \rightarrow MgSO_4 + 1/2H_2O$). That is, the microwave heating in the

secondary drying is to heat the molding so as to achieve the above-mentioned purpose, therefore, the heating duration is relatively long (for example, five minutes as disclosed in the preferred embodiment).

As explained above, the microwave heating in the secondary drying of JP '745 is not to make the inorganic sulfate compound exist in a state of hydrate containing crystal water after drying. In other words, JP '745 discloses the microwave heating only as a type of heating means for drying molding.

Also, JP '745 does not teach or suggest the technical idea of making the inorganic sulfate compound exist in a state of hydrate containing crystal water after drying, and thereby, increasing the strength of a water-soluble casting mold. Furthermore, JP '745 does not teach or suggest the technical idea of using magnesium sulfate in combination with another inorganic sulfate compound (i.e., at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate) which easily forms a mixed crystal with magnesium sulfate at the time of drying, thereby increasing the strength of a water-soluble casting mold at the time of drying, and also restraining the decrease in the strength of a water-soluble casting mold at the time of moisture absorption.

Therefore, the claimed invention as set forth in claim 12 (which depends from amended independent claim 7) is patentable under 35 U.S.C. § 103(a) over JP '724 in view of Berg in further view of JP '745.

F. U.S. Patent No. 4,761,264 ("Nishio")

Nishio is directed to a method for molding powders by using a cold isostatic press method. In this method, a thin-wall resilient mold is introduced inside a ventilative mold support, thereafter, the outside pressure of the ventilative mold support is reduced to less than atmospheric pressure, thereby, the thin-wall resilient mold is put exactly close to the inside

wall of the ventilative mold support. Powder material is then supplied into the thin-wall resilient mold.

That is, in the method disclosed by Nishio, the function of the ventilative mold support is to make the thin-wall resilient mold put exactly close to the inside wall thereof by forming a vacuum inside the ventilative mold support.

In the claimed invention as set forth in claim 13, a ventilative ceramic mold which is to be filled with the casting mold is used to release the evaporated water evenly to the outside from the ceramic mold at the time of drying the casting sand. Thereby, unevenness of crystal water contained in the inorganic sulfate compound is restrained, so that the strength of the manufactured mold can be made uniform. As such, the function of the ventilative ceramic mold in the claimed invention as set forth in claim 13 is quite different from the function of the ventilative mold support disclosed by Nishio.

Also, Nishio does not teach or suggest the technical idea of making the inorganic sulfate compound exist in a state of hydrate containing crystal water after drying, and thereby, increasing the strength of a water-soluble casting mold. Furthermore, Nishio does not teach or suggest the technical idea of using magnesium sulfate in combination with another inorganic sulfate compound (i.e., at least one other inorganic sulfate compound selected from aluminum sulfate, sodium sulfate, nickel sulfate, and manganese sulfate) which easily forms a mixed crystal with magnesium sulfate at the time of drying, thereby increasing the strength of a water-soluble casting mold at the time of drying, and also restraining the decrease in the strength of a water-soluble casting mold at the time of moisture absorption.

Therefore, the claimed invention as set forth in claim 13 (which depends from amended independent claim 7) is patentable under 35 U.S.C. § 103(a) over JP '724 in view of Berg in further view of Nishio.

CONCLUSION

In summary, claims 1, 3-7, and 9-13, as amended, meet the substantive requirements for patentability. The case is in appropriate condition for allowance. Accordingly, such action is respectfully requested.

If a telephone or video conference would expedite allowance or resolve any further questions, such a conference is invited at the convenience of the Examiner.

Respectfully submitted,
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